APEX Vision Capabilities and HEM

John Rehling
NASA Ames Research Center
October 19, 2001

Initial Stock of Vision Routines in Apex

`vis-examine` `?item ?time`
Input: item
Output: knowledge of all the visual properties of the item

`shift-gaze-to` `?visob`
Input: item
Output: visual examination of item after redirection of gaze

`find all` `?feature in ?region`
Input: feature, region
Output: set of objects meeting those criteria

`read-word` `?index ?textblock`
Input: word
Output: knowledge of that word

Capabilities Added, ‘01

Text reading
Input: text color, background color/texture, size, serifs?
Output: legible?, reading speed

Detectibility of a visual stimulus
Input: luminosity, contrast, light/dark adaptation, retinal eccentricity
Output: detected?

Single-character recognition
Input: character, size, contrast
Output: perceived letter (not necessarily correct), reaction time

Based upon psychological and psychophysical results in:
[Legge, et al, 1985]
[Boff and Lincoln, 1988]
[Legge, et al, 1990]
[Daltroy, 1999]
[Scharff, Hill, and Ahumada, 2000]

Example output

Text legibility / Reading speed

Text black, background white, size 1°
320 WPM

Text beige, background tan, size 0.4°
170 WPM

Text black, background white, size 0.1°
145 WPM

Text black, background white, size 0.05°
Illegible

Text gray, background black and white stripes at 100 cycles per degree, size 0.5°
Illegible

Character recognition

“P”, at 75% correct
`P P P R P P P F F P`

“8”, at 35% correct
`R G 8 S 8 r 8 S G G`

“a”, at 90% correct
`d a a a a a a a a a`

“a”, size 0.18°
`a o a a m m e 6 a d`

Reading Speed Predictions, how derived

Input: RGB_1 (text color), RGB_2 (background color), size (per letter)
D: difficulty (due to perceptual properties of text)
Z: reading speed (plain English, words per minute)

K_1, K_2: RGB_1, RGB_2 mapped to L*U*V* space
JNDs: distance(K1, K2)
c_{lum}: luminance contrast
    abs(K1(L*) – K2(L*))
c_{color}: chromatic contrast
    weight • JNDs
f: adjusts difficulty in terms of contrast
    calculated by interpolating between data points from the literature
g: reading speed in terms of difficulty
    calculated by interpolating between data points from the literature

$D = -11 \ln (size \bullet f (\max (c_{lum}, c_{color}))) - 18.42$
    combines results from the literature

$Z = g(D)$

Tests of Illegibility
    If JNDs<8, contrast<0.03, size < 0.06°, or Z < 28